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(54) VEHICULAR COMMUNICATION APPARATUS, AND VEHICLE CONTROL SYSTEM AND TRAFFIC SYSTEM USING THE VEHICULAR COMMUNICATION APPARATUS

(71) Applicant: **SUBARU CORPORATION**, Tokyo (JP)

(72) Inventors: **Haruyo Miyakawa**, Tokyo (JP); **Hyoungwook Choi**, Tokyo (JP); **Satoru Ikeda**, Tokyo (JP)

(73) Assignee: **SUBARU CORPORATION**, Tokyo (JP)

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G08G 1/052 (2006.01)
G08G 1/01 (2006.01)

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CPC ***G08G 1/093*** (2013.01); ***G08G 1/0112*** (2013.01); ***G08G 1/052*** (2013.01)

(58) **Field of Classification Search**
CPC G08G 1/093; G08G 1/0112; G08G 1/052
USPC 340/905
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,372,261 B2 *	6/2016	Aoki	G01S 13/584	
2005/0017857 A1 *	1/2005	Rao	B60Q 9/008	340/435
2005/0024258 A1 *	2/2005	Matsuoka	G01S 7/411	342/70
2012/0150437 A1 *	6/2012	Zeng	G01C 21/30	701/456
2013/0006469 A1 *	1/2013	Green	B60R 21/013	701/36
2013/0223686 A1 *	8/2013	Shimizu	G08G 1/166	382/103

(Continued)

FOREIGN PATENT DOCUMENTS

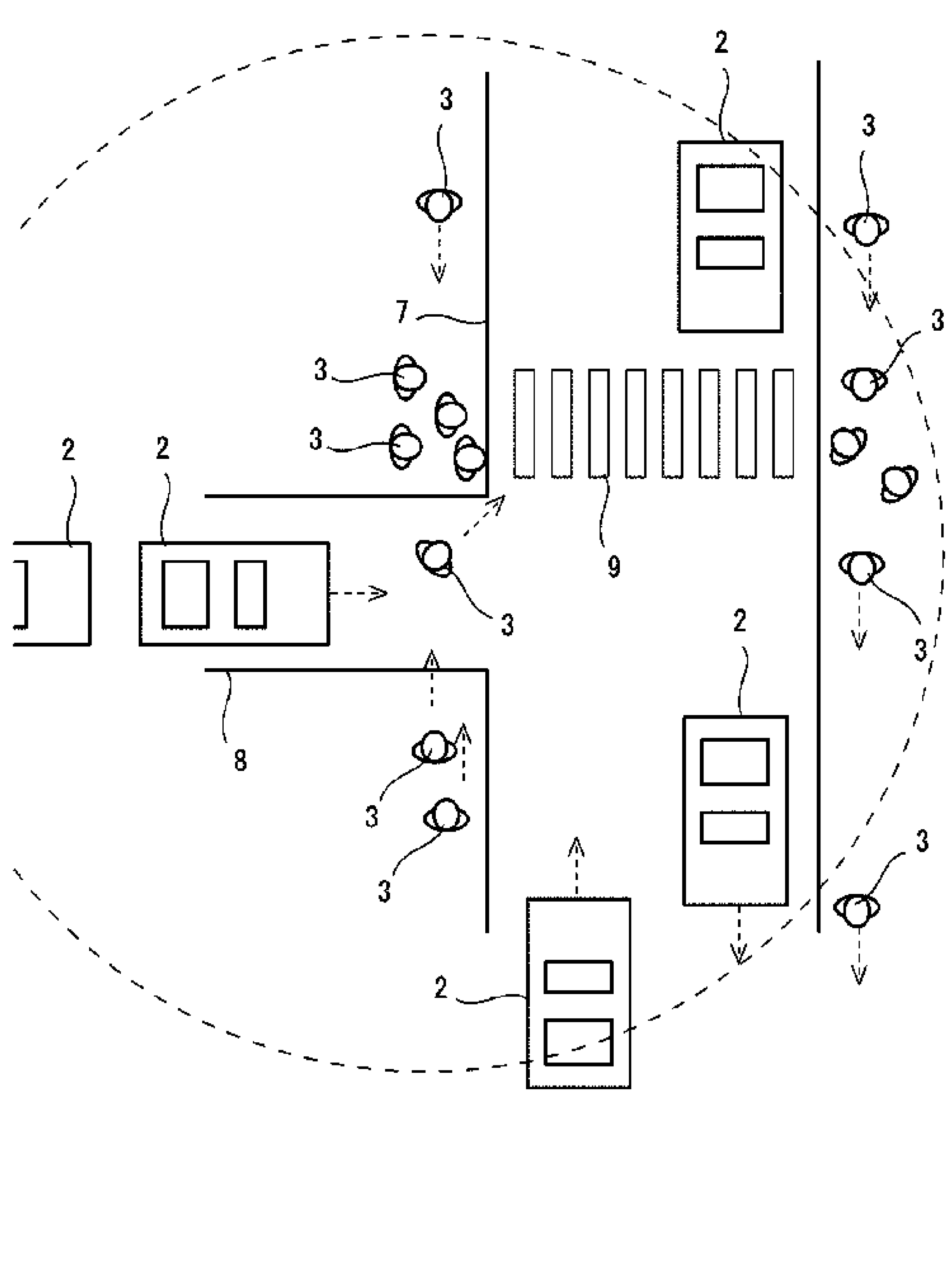
JP	2015207940	11/2015
JP	2018101384	6/2018

Primary Examiner — Naomi J Small
(74) *Attorney, Agent, or Firm* — Chip Law Group

(57) **ABSTRACT**

A vehicular communication apparatus configured to receive movement data related to a movement of other movable bodies includes an acquiring unit, a memory, and a data managing unit. The acquiring unit is configured to acquire the movement data on the other movable bodies. The memory is configured to store and record therein the movement data acquired by the acquiring unit. The data managing unit is configured to manage the record of the movement data in the memory. The data managing unit is configured to acquire a speed of each movable body that is obtained from the movement data recorded in the memory, and invalidate or delete the movement data recorded in the memory on a movable-body by movable-body basis in accordance with the acquired speed of the each movable body.

13 Claims, 8 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2014/0062725	A1*	3/2014	Maston	G08G 1/0112 340/905
2015/0234044	A1*	8/2015	Ouchi	G08G 1/166 342/27
2015/0269844	A1*	9/2015	Arndt	G08G 1/167 340/435
2016/0034767	A1*	2/2016	Saptharishi	G08B 13/19613 348/143
2016/0155004	A1*	6/2016	Shiraishi	G06K 9/00335 348/77
2016/0371975	A1*	12/2016	Yamamoto	G08G 1/096716
2017/0034667	A1	2/2017	Kumabe et al.	
2017/0057474	A1*	3/2017	Zeng	B60T 7/22
2017/0116861	A1*	4/2017	Ichihara	G08G 1/0112
2018/0032042	A1*	2/2018	Turpin	B64D 47/08
2018/0181824	A1*	6/2018	Ishii	G08G 1/09623

* cited by examiner

FIG. 1

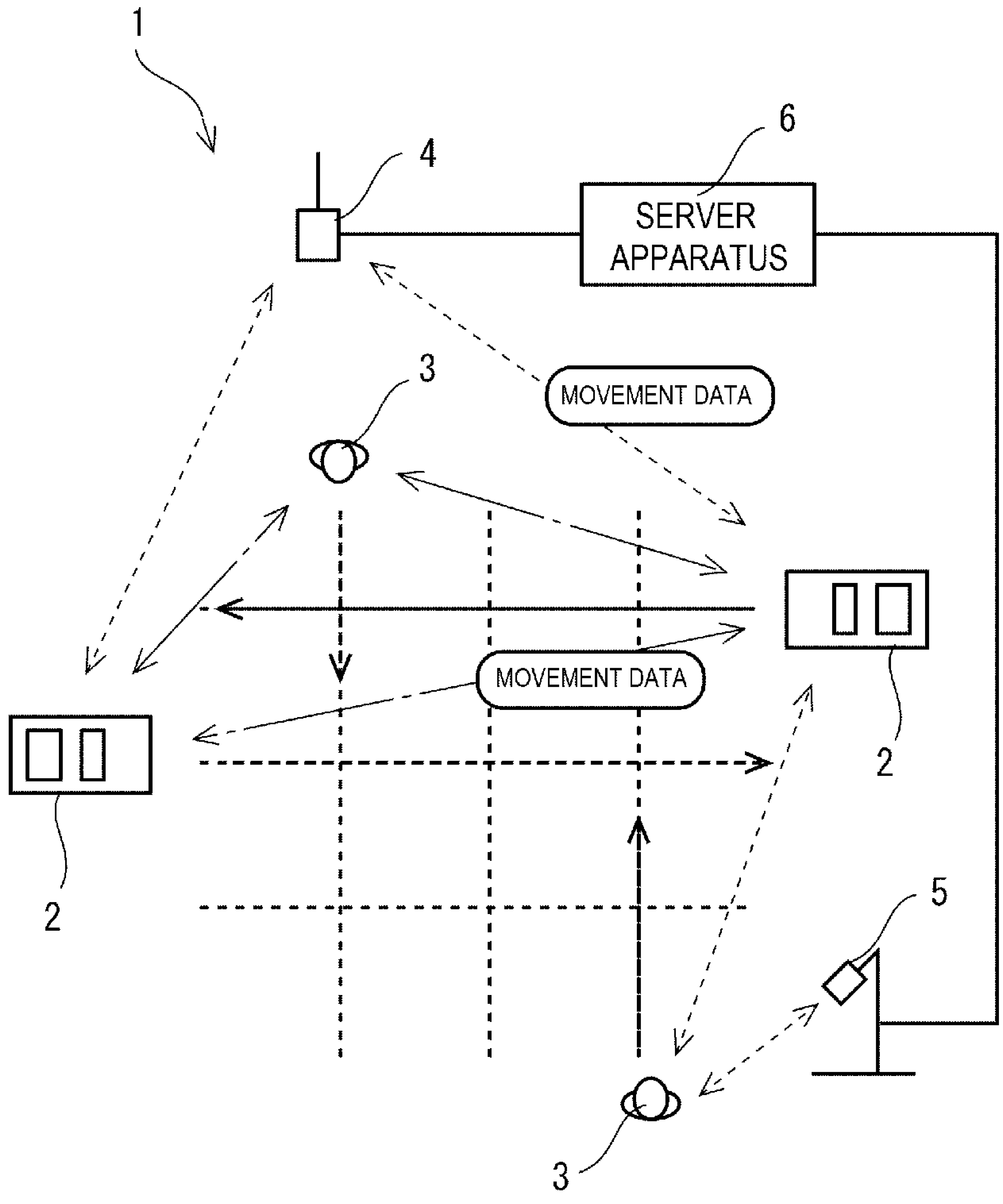


FIG. 2

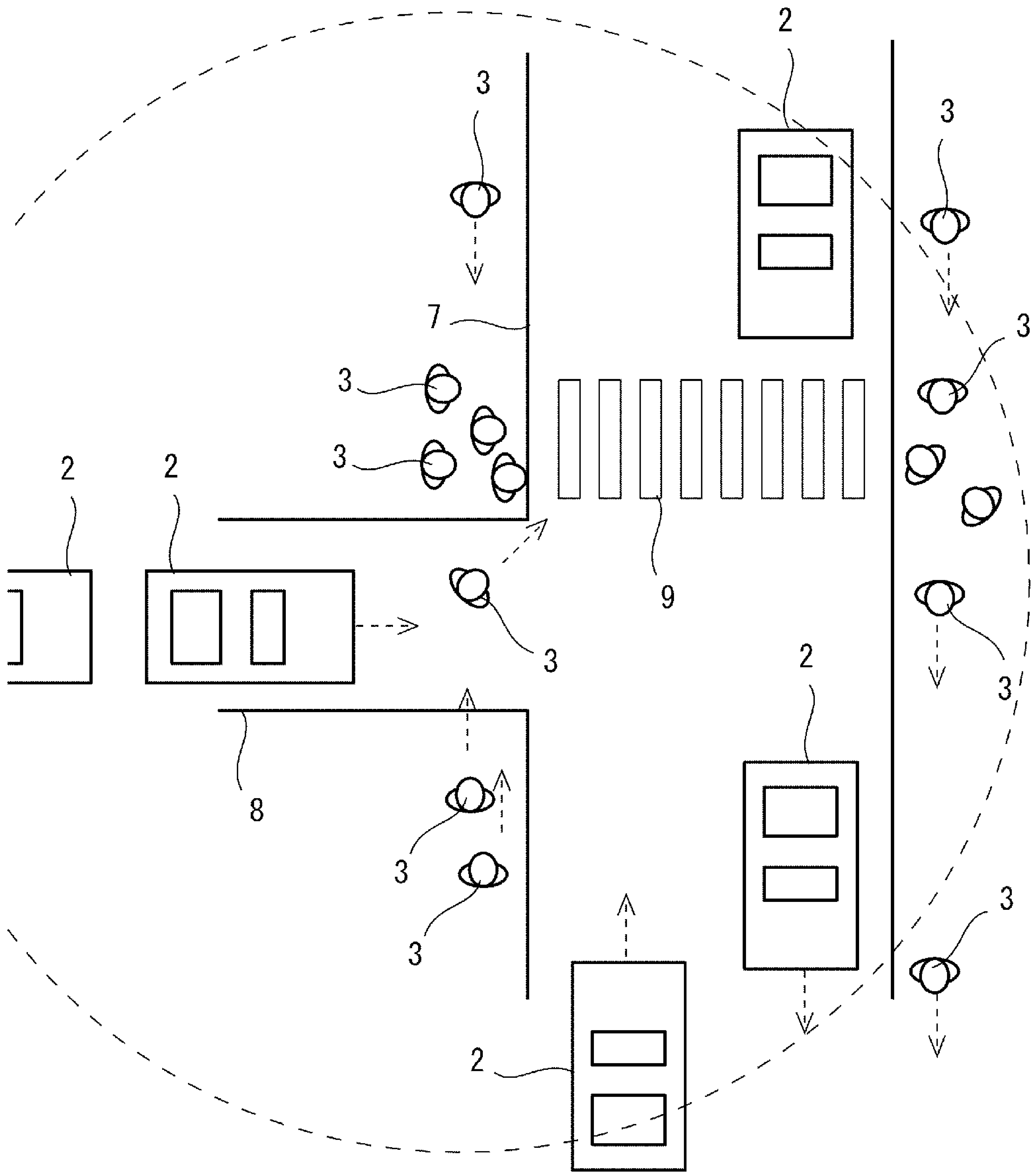


FIG. 3A

FIG. 3B

FIG. 3C

FIG. 3D

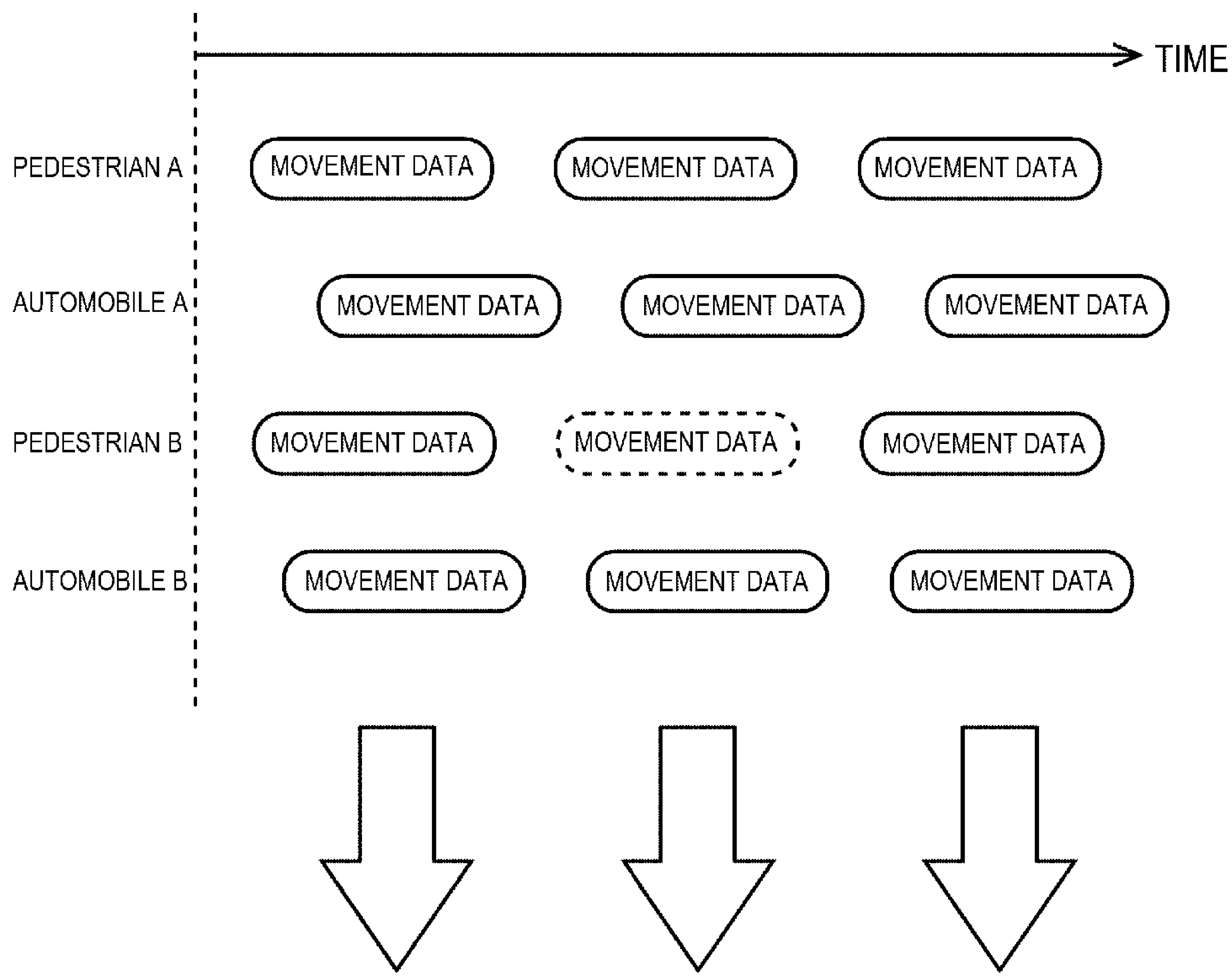


FIG. 3E

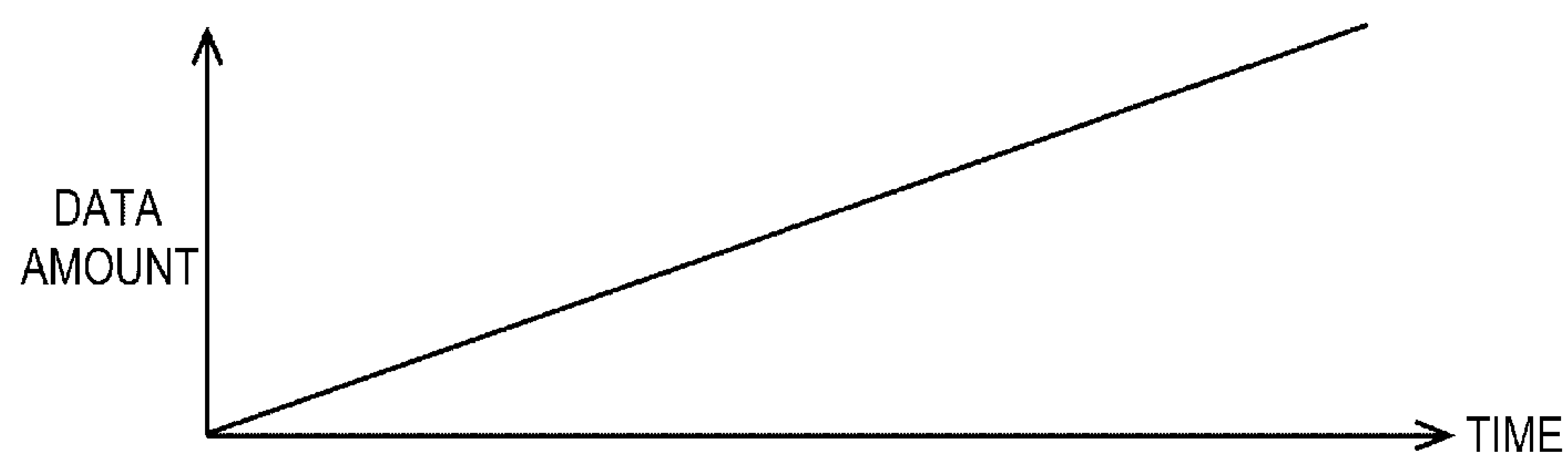


FIG. 4

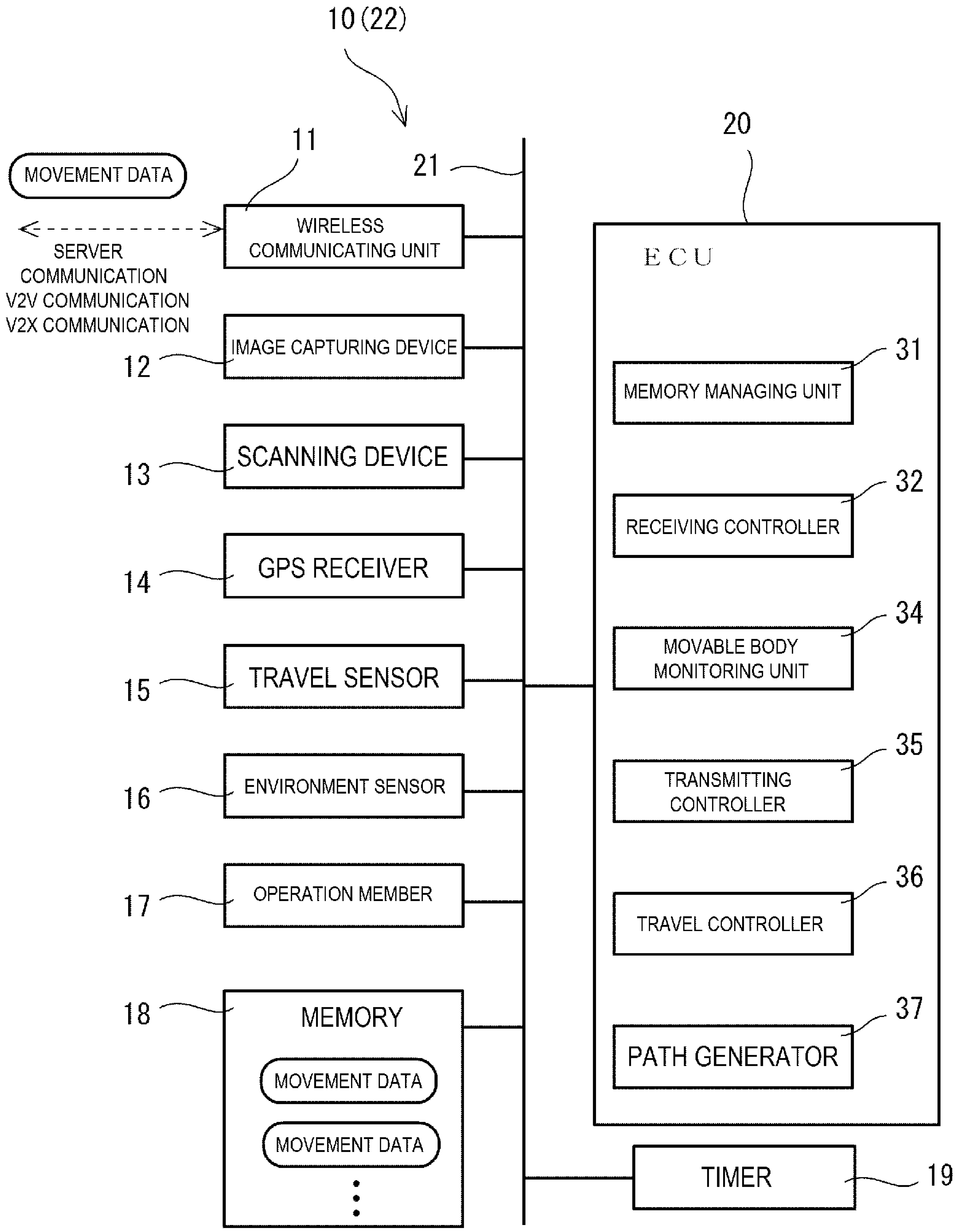

10 (22)
20
11
21
MOVEMENT DATA
WIRELESS COMMUNICATING UNIT
SERVER COMMUNICATION
V2V COMMUNICATION
V2X COMMUNICATION
ECU
12
IMAGE CAPTURING DEVICE
31
MEMORY MANAGING UNIT
13
SCANNING DEVICE
32
RECEIVING CONTROLLER
14
GPS RECEIVER
34
MOVABLE BODY MONITORING UNIT
15
TRAVEL SENSOR
35
TRANSMITTING CONTROLLER
16
ENVIRONMENT SENSOR
17
OPERATION MEMBER
36
TRAVEL CONTROLLER
18
MEMORY
MOVEMENT DATA
MOVEMENT DATA
37
PATH GENERATOR
TIMER
19

FIG. 5

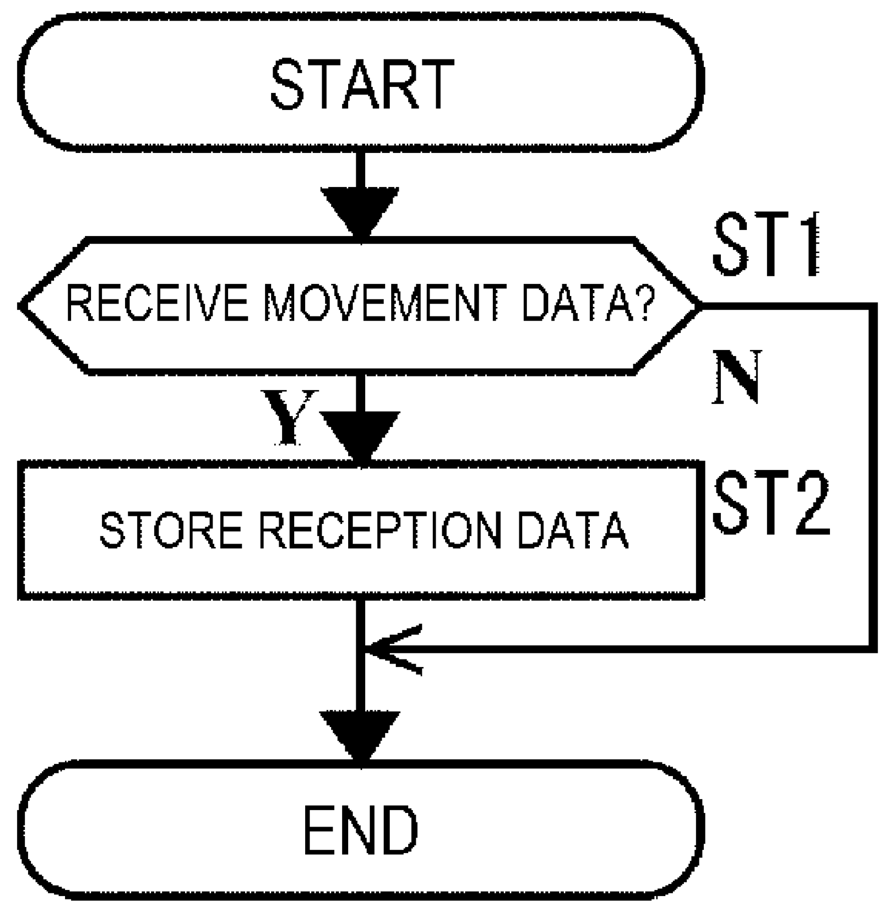


FIG. 6

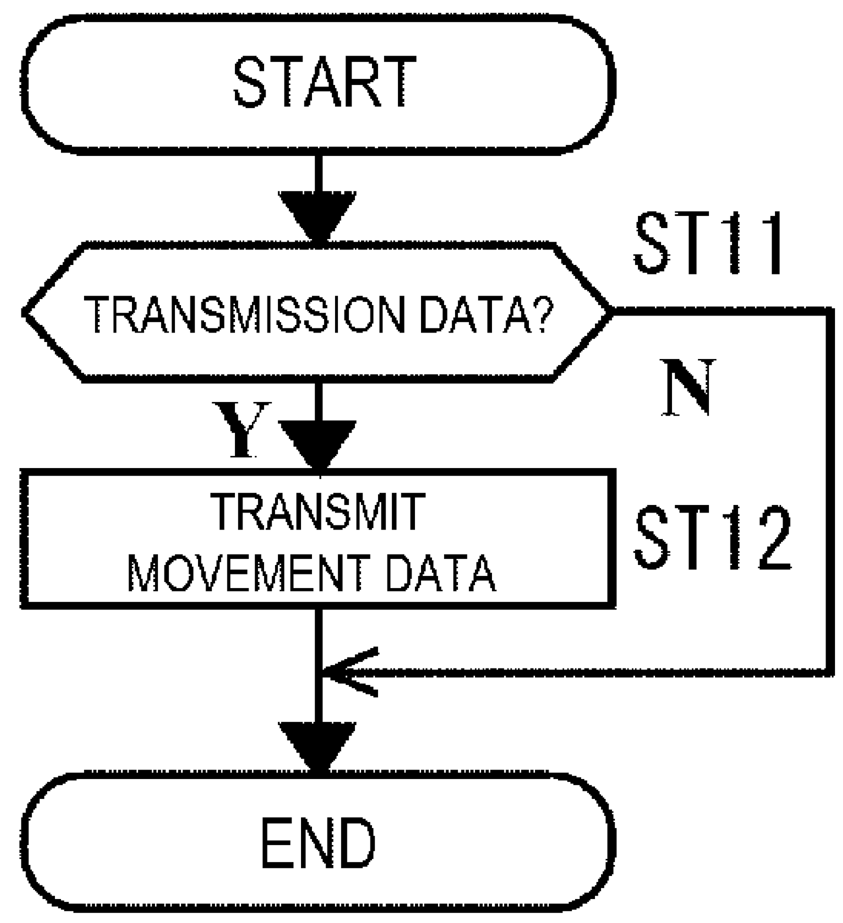


FIG. 7

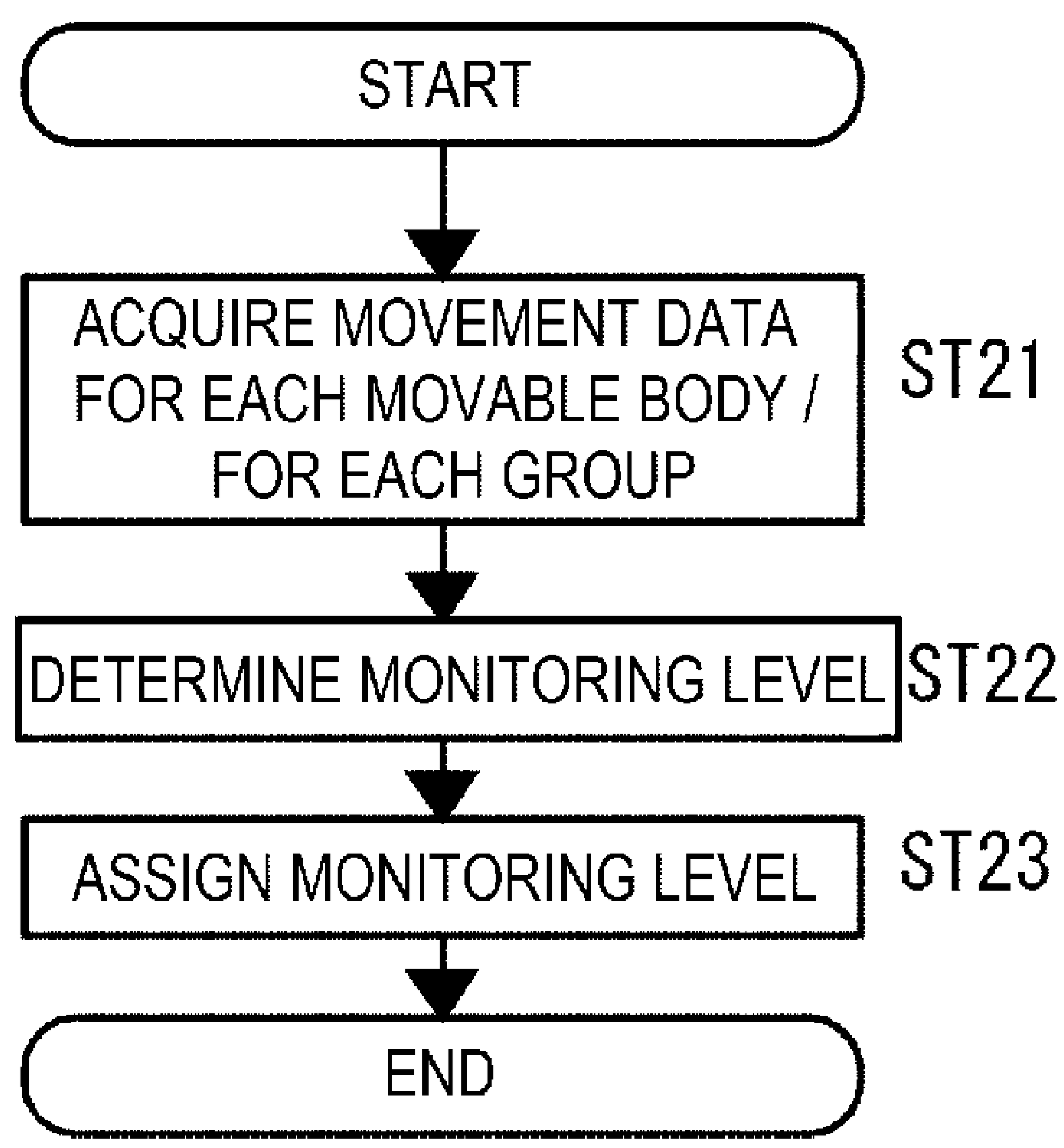


FIG. 8

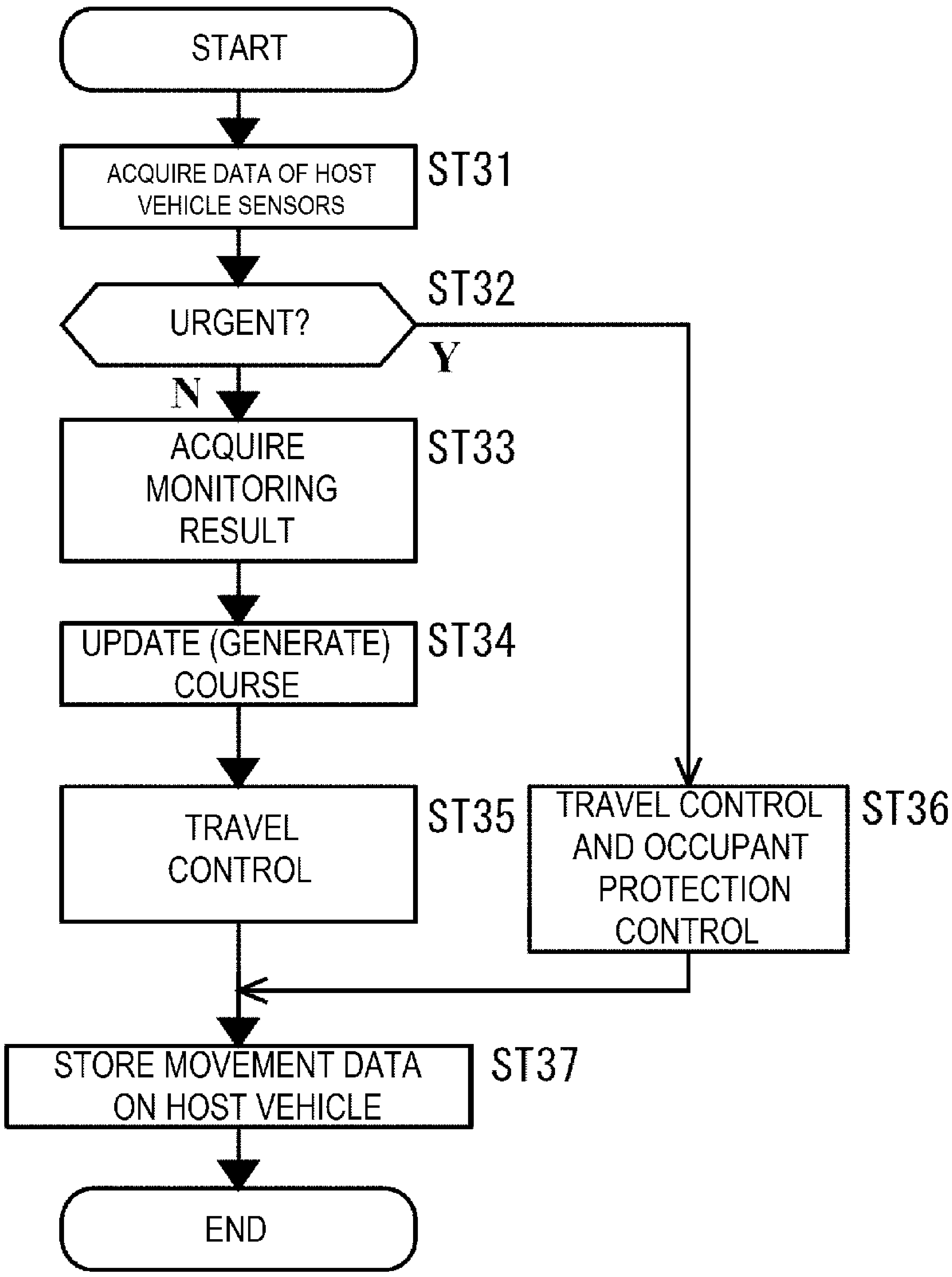

START
ACQUIRE DATA OF HOST VEHICLE SENSORS
ST31
URGENT?
ST32
Y
N
ACQUIRE MONITORING RESULT
ST33
UPDATE (GENERATE) COURSE
ST34
TRAVEL CONTROL
ST35
TRAVEL CONTROL AND OCCUPANT PROTECTION CONTROL
ST36
STORE MOVEMENT DATA ON HOST VEHICLE
ST37
END

FIG. 9

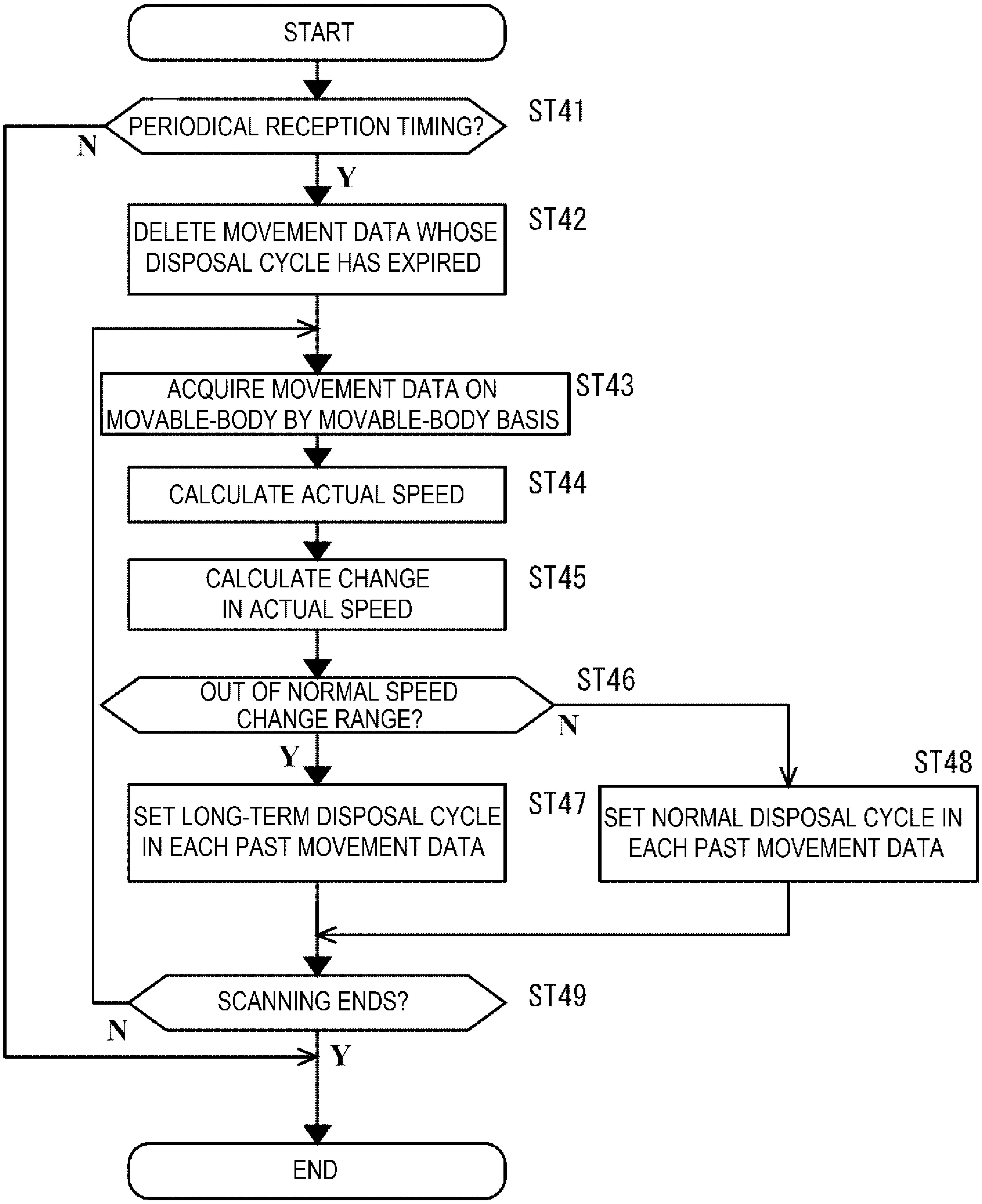
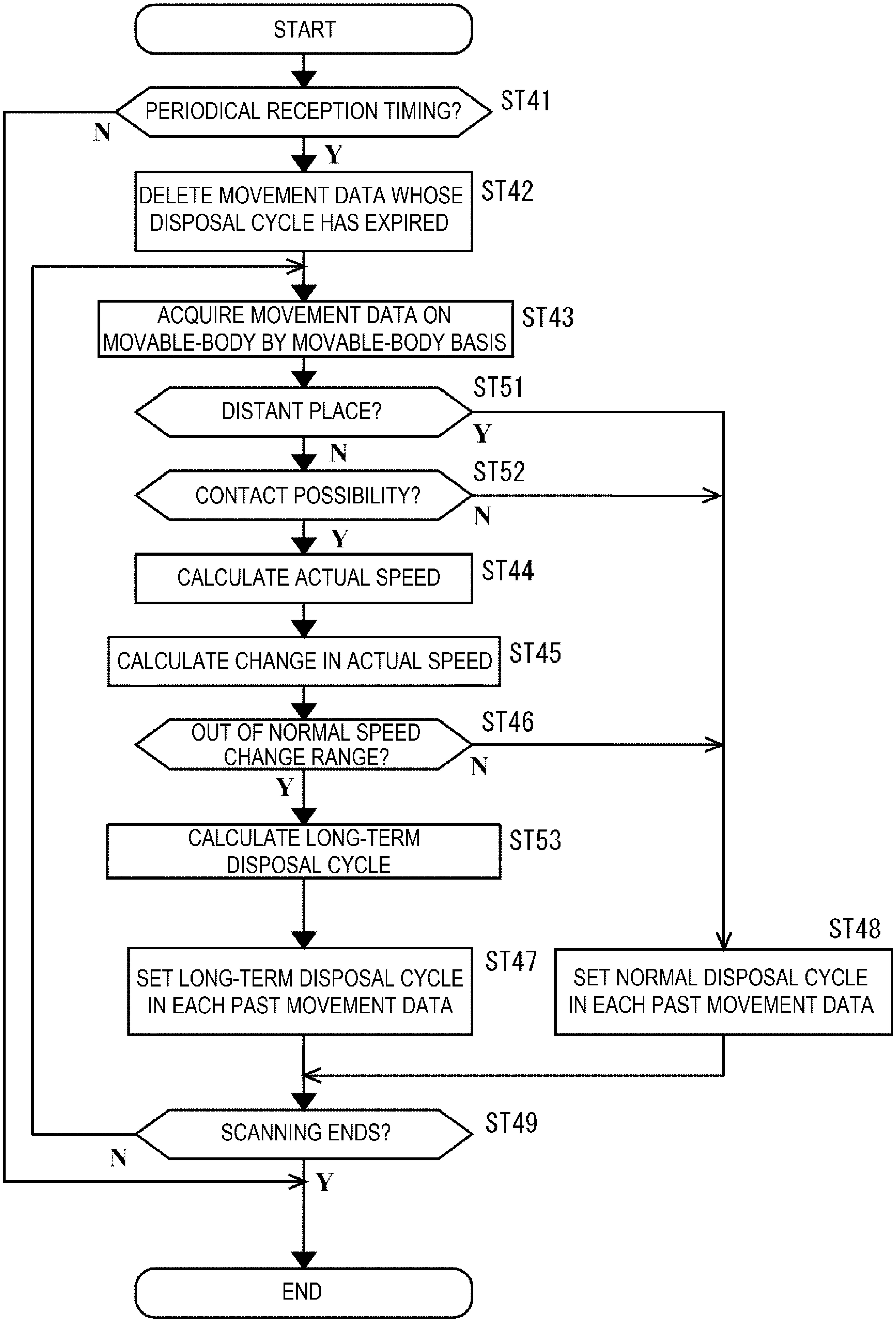

START
PERIODICAL RECEPTION TIMING?
ST41
N
Y
DELETE MOVEMENT DATA WHOSE DISPOSAL CYCLE HAS EXPIRED
ST42
ACQUIRE MOVEMENT DATA ON MOVABLE-BODY BY MOVABLE-BODY BASIS
ST43
CALCULATE ACTUAL SPEED
ST44
CALCULATE CHANGE IN ACTUAL SPEED
ST45
OUT OF NORMAL SPEED CHANGE RANGE?
ST46
N
Y
SET LONG-TERM DISPOSAL CYCLE IN EACH PAST MOVEMENT DATA
ST47
SET NORMAL DISPOSAL CYCLE IN EACH PAST MOVEMENT DATA
ST48
SCANNING ENDS?
ST49
N
Y
END

FIG. 10


START
PERIODICAL RECEPTION TIMING?
ST41
N
Y
DELETE MOVEMENT DATA WHOSE DISPOSAL CYCLE HAS EXPIRED
ST42
ACQUIRE MOVEMENT DATA ON MOVABLE-BODY BY MOVABLE-BODY BASIS
ST43
DISTANT PLACE?
ST51
Y
N
CONTACT POSSIBILITY?
ST52
N
Y
CALCULATE ACTUAL SPEED
ST44
CALCULATE CHANGE IN ACTUAL SPEED
ST45
OUT OF NORMAL SPEED CHANGE RANGE?
ST46
N
Y
CALCULATE LONG-TERM DISPOSAL CYCLE
ST53
SET LONG-TERM DISPOSAL CYCLE IN EACH PAST MOVEMENT DATA
ST47
SET NORMAL DISPOSAL CYCLE IN EACH PAST MOVEMENT DATA
ST48
SCANNING ENDS?
ST49
N
Y
END

VEHICULAR COMMUNICATION APPARATUS, AND VEHICLE CONTROL SYSTEM AND TRAFFIC SYSTEM USING THE VEHICULAR COMMUNICATION APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority from Japanese Patent Application No. 2018-181319 filed on Sep. 27, 2018, the entire contents of which are hereby incorporated by reference.

BACKGROUND

The disclosure relates to a vehicular communication apparatus, and a vehicle control system and a traffic system using the same.

In recent years, as for vehicles such as automobiles on which persons get when moving, it has been considered to assist or automatically control the travel of the vehicles and the operation of devices that are used in the vehicles. Moreover, in order to improve, for instance, the safety, the smoothness, the movement cost, the comfortableness, and the environmental friendliness of vehicles when moving, it is desirable to control the vehicles, not only based on information separately detected by each vehicle, but also using complex information obtained by widely acquiring and collecting information related to movements of other movable bodies such as the other vehicles except the host vehicle and pedestrians, and information on a travel environment.

Traffic systems available for this purpose include, for instance, an intelligent transport system (ITS), a cooperative ITS, universal traffic management systems (UTMS), an advanced rapid transit (ART), and a public transportation priority system (PTPS), and the study and the development of these systems have been progressed. Moreover, as for the cooperative ITS, the standard TC204/WG18 is formulated.

SUMMARY

An aspect of the disclosure provides a vehicular communication apparatus configured to receive movement data related to a movement of other movable bodies. The vehicular communication apparatus includes an acquiring unit, a memory, and a data managing unit. The acquiring unit is configured to acquire the movement data on the other movable bodies. The memory is configured to store and record therein the movement data acquired by the acquiring unit. The data managing unit is configured to manage the record of the movement data in the memory. The data managing unit is configured to acquire a speed of each movable body that is obtained from the movement data recorded in the memory, and invalidate or delete the movement data recorded in the memory on a movable-body by movable-body basis in accordance with the acquired speed of the each movable body.

An aspect of the disclosure provides a vehicle control system including the above vehicular communication apparatus and a vehicle control apparatus. The vehicle control apparatus is configured to control a vehicle using the movement data recorded in the memory of the vehicular communication apparatus.

An aspect of the disclosure provides a traffic system including the above vehicular communication apparatus and a server apparatus. The server apparatus is configured to transmit and receive movement data related to the movements of the movable bodies to and from the vehicular communication apparatus.

An aspect of the disclosure provides a vehicular communication apparatus configured to receive movement data related to a movement of other movable bodies. The vehicular communication apparatus includes circuitry. The circuitry is configured to acquire the movement data on the other movable bodies. The circuitry is configured to store and record therein the acquired movement data by the acquiring unit. The circuitry is configured to manage the record of the movement data. The circuitry is configured to acquire a speed of each movable body that is obtained from the movement data recorded in the memory, and invalidate or delete the recorded movement data on a movable-body by movable-body basis in accordance with the acquired speed of the each movable body.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this specification. The drawings illustrate example embodiments and, together with the specification, serve to explain the principles of the disclosure.

FIG. **1** is a schematic explanatory diagram illustrating an instance of a traffic system according to some embodiments of the disclosure.

FIG. **2** is an explanatory diagram illustrating an instance in which vehicles and pedestrians are moving as a plurality of movable bodies.

FIG. **3**A to FIG. **3**E are explanatory diagrams illustrating a correspondence relationship between generation status of movement data related to the movements of the plurality of movable bodies and the amount of data stored in a memory.

FIG. **4** is an explanatory diagram illustrating an instance of a vehicle control system that is provided with a vehicular communication apparatus according to the embodiment of the disclosure.

FIG. **5** is an explanatory diagram illustrating an instance of processing of a receiving controller in FIG. **4**.

FIG. **6** is an explanatory diagram of an instance of processing of a transmitting controller in FIG. **4**.

FIG. **7** is an explanatory diagram illustrating an instance of processing of a movable body monitoring unit in FIG. **4**.

FIG. **8** is an explanatory diagram illustrating an instance of processing of a travel controller serving as a vehicle control apparatus in FIG. **4**.

FIG. **9** is an explanatory diagram of an instance of processing of a memory managing unit in FIG. **4** according to a first embodiment of the disclosure.

FIG. **10** is an explanatory diagram of an instance of processing of the memory managing unit in FIG. **4** according to a second embodiment of the disclosure.

DETAILED DESCRIPTION

In the following, some embodiments of the disclosure are described in detail with reference to the accompanying drawings. Note that sizes, materials, specific values, and any other factors illustrated in respective embodiments are illustrative for easier understanding of the disclosure, and are not intended to limit the scope of the disclosure unless otherwise specifically stated. Further, elements in the following example embodiments which are not recited in a mostgeneric independent claim of the disclosure are optional and may be provided on an as-needed basis. Throughout the present specification and the drawings, elements having substantially the same function and configuration are denoted with the same reference numerals to avoid any redundant description. Further, elements that are not directly related to the disclosure are unillustrated in the drawings. The drawings are schematic and are not intended to be drawn to scale. In a situation in which information on movable bodies and the like can be actually transmitted and received, vehicles such as automobiles that collect and process movement data on movements of movable bodies would be to acquire a large amount of movement data and to use the data for control of the vehicles.

However, a vehicle of related art such as an automobile simply processes data detected by the host vehicle, and receives and processes static congestion data into which movements of individual movable bodies are collectively abstracted and partial map data for guiding a path, in an area including the host vehicle position.

In other words, even if a technology enables current vehicles to widely collect information on movable bodies, the current vehicles cannot appropriately acquire widely collected dynamic movement data on a large number of the movable bodies and control the travel or the like of the vehicles based on the acquired large amount of the dynamic movement data.

Japanese Unexamined Patent Application Publication (JP-A) No. 2015-207940 discloses a technique of deleting old data, as a technique under study and development. JP-A No. 2018-101384 discloses a technique of deleting data after a predetermined time has elapsed.

However, those techniques basically delete old data uniformly. When these techniques are applied to a large amount of dynamic movement data on movable bodies, there is a possibility that the data to be deleted may contain useful data. Moreover, there is a possibility that unnecessary data may remain in new data to be not deleted. Such data remains to cause not only the shortage of the memory, but also there is a possibility that the vehicle can never move forward or the movement of the vehicle is unnecessarily and excessively reactive.

It is desirable for a vehicle such as an automobile to appropriately acquire movement data on a plurality of movable bodies that can be collected.

First Embodiment

FIG. **1** is a schematic explanatory diagram illustrating an instance of a traffic system **1** according to embodiments of the disclosure.

FIG. **1** illustrates a plurality of vehicles **2** serving as a plurality of movable bodies, and a plurality of pedestrians **3** serving as low-speed movable bodies. In the vehicles **2** such as automobiles on which persons get when moving, assisting or automatically controlling the travel of the vehicles **2** and the operation of devices that are used in the vehicles **2** have become available. In addition to an automobile or an electric vehicle on which a plurality of persons can get, instances of the vehicles **2** include a motor cycle, a personal mobility aid, a cart, and an electric wheelchair.

The traffic system **1** in FIG. **1** includes a plurality of vehicular communication apparatuses, a plurality of pedestrian communication devices, a base station **4**, a beacon apparatus **5**, and a server apparatus **6**. The plurality of vehicular communication apparatuses are respectively provided to the vehicles **2** such as automobiles. The plurality of pedestrian communication devices are respectively carried by the low-speed movable bodies such as the pedestrians **3**. FIG. **1** illustrates the vehicles **2** in place of the vehicular communication apparatuses and the pedestrians **3** in place of the pedestrian communication device. The traffic system **1** may use a base station of a commercial wireless communication and a communication device that is disposed on a road shoulder of a highway, as the base station **4**.

In the traffic system **1** in FIG. **1**, the communication device of each of the vehicles **2** and the pedestrians **3** transmits movement data related to a movement itself as a movable body to the server apparatus **6** via the base station **4** or the beacon apparatus **5**. The server apparatus **6** collects the movement data related to the movements of the plurality of movable bodies, generates data on traffic information as necessary based on the collected movement data, and transmits the movement data and the data on the traffic information to the communication devices. The server apparatus **6** transmits and receives the movement data related to the movements of the movable bodies, to and from the vehicular communication apparatuses.

In the traffic system **1** in FIG. **1**, the communication device of each of the vehicles **2** and the pedestrians **3** transmits the movement data related to the movement itself as a movable body to another communication device that is in the vicinity thereof.

Upon receipt of the movement data and the like from the server apparatus **6** or a communication device of another movable body, each communication device stores and uses the movement data and the like for control of the movement itself.

For instance, in FIG. **1**, the right-hand vehicle **2** travels straight leftward. The left-hand vehicle **2** in FIG. **1** travels straight rightward. The right-hand vehicle **2** and the left-hand vehicle **2** in FIG. **1** pass each other on a bidirectional road, for instance.

The lower-right-hand pedestrian **3** in FIG. **1** travels straight upward. Before the lower-right-hand pedestrian **3** with a low movement speed reaches an intersecting position of courses of the right-hand vehicle **2** and the left-hand vehicle **2** in FIG. **1**, the right-hand vehicle **2** and the left-hand vehicle **2** have passed the intersecting position.

In contrast, the upper-left-hand pedestrian **3** in FIG. **1** travels straight downward. Accordingly, there is a possibility that before and after the timing when the upper-left-hand pedestrian **3** reaches an intersecting position, the right-hand vehicle **2** in FIG. **1** may reach the intersecting position.

In this case, the vehicular communication apparatus mounted on the right-hand vehicle **2** in FIG. **1** accelerates or decelerates the movement speed of the host vehicle so that the right-hand vehicle **2** does not pass through the intersecting position simultaneously with the upper-left-hand pedestrian **3**, based on pre-received movement data related to the movement of the upper-left-hand pedestrian **3**.

It is expected that the traffic system **1** transmits and receives movement data related to movements of a plurality of movable bodies to and from the plurality of movable bodies to allow the plurality of movable bodies to move in safety.

For instance, the vehicle **2** can control the vehicle **2** not only based on information detected by the vehicle **2** itself, but also using complex information obtained by widely acquiring and collecting (i) information related to movements of other movable bodies, such as other vehicles than the host vehicle, and the pedestrians **3**, and (ii) information on an travel environment.

Transmitting and receiving the movement data among the plurality of movable bodies using the traffic system. **1** in this manner can improve the safety, the smoothness, the movement cost, the comfortableness, and the environmental friendliness of the movements of the movable bodies.

The traffic system **1** available for such a case includes, for instance, an intelligent transport system (ITS), a cooperative ITS, universal traffic management systems (UTMS), an advanced rapid transit (ART), and a public transportation priority system (PTPS). The cooperative ITS is standardized by the standard TC204/WG18.

FIG. **2** is an explanatory diagram illustrating an instance in which the vehicles **2** and the pedestrians **3** are moving as a plurality of movable bodies.

FIG. **2** illustrates a main road **7** that extends in the vertical direction, and an alley **8** that extends in the left direction from the main road **7**. The vehicles **2** such as automobiles move on central portions of the main road **7** and the alley **8**. The pedestrians **3** move on side portions of the main road **7** and the alley **8**. Moreover, the pedestrians **3** stop before a pedestrian crossing **9** on a red traffic signal, and cross the main road **7** on the pedestrian crossing **9** when the traffic signal turns to green. FIG. **2** illustrates a large number of the pedestrians **3** and a large number of the vehicles **2**.

In order to achieve the above-mentioned object of the traffic system **1**, the vehicle **2** that travels on the main road **7** from the lower part to the upper part in FIG. **2** in such a travel environment, for instance, is cautious about not only another vehicle **2** such as an oncoming vehicle that travels on the same main road **7**, but also a large number of pedestrians **3** that walk on the road side stripe near the vehicle **2**, the pedestrian **3** and the vehicle **2** that appear from the alley **8**, and travels by finely adjusting a course thereof so as not to come into contact, such as collision, with these.

Accordingly, the vehicle **2** is to instantaneously acquire movement data having information, such as the positions and the speed of a large number of other movable bodies that are present in the surrounding thereof. This enables the vehicle **2**, when passing by another movable body, to adjust the course so as not to come into contact with the other movable body.

Each movable body is to continuously acquire the latest movement data on a large number of other movable bodies that are present in the surrounding of the movable body itself. For instance, the vehicle **2** that is located at the head on the alley **8** is to continuously acquire the latest movement data on a large number of other movable bodies that are in an area surrounded by a circular dashed line.

Moreover, each movable body is unable to limit the number of other movable bodies that are present in the surrounding thereof by the movable body itself.

FIG. **3**A to FIG. **3**E are explanatory diagrams illustrating a correspondence relationship between a generation status of movement data related to movements of a plurality of movable bodies and the amount of data stored in a memory **18**.

FIG. **3**A illustrates plural pieces of movement data on a pedestrian A.

FIG. **3**B illustrates plural pieces of movement data on a vehicle A.

FIG. **3**C illustrates plural pieces of movement data on a pedestrian B.

FIG. **3**D illustrates plural pieces of movement data on a vehicle B.

In FIG. **3**A to FIG. **3**D, the plural pieces of movement data are generated in order from the left side to the right side.

FIG. **3**E illustrates a time change graph illustrating the total data amount of the movement data from FIG. **3**A to FIG. **3**D.

As illustrated in the graph in FIG. **3**E, the total data amount of the movement data proportionally increases in accordance with the elapse of time. Moreover, the increase ratio of the total data amount becomes larger as the number of movable bodies increases more.

In order to achieve the object of the traffic system **1**, as illustrated in FIG. **3**A to FIG. **3**D, each movable body repeatedly transmits movement data having information, such as the latest position and speed thereof, at as short intervals as possible.

As a result, as illustrated in FIG. **3**E, the total data amount of the movement data that are transmitted and received among the plurality of movable bodies dramatically increases in accordance with the number of movable bodies to be collected and the elapsed time from when the collection is started. The amount of data stored in the memory by each movable body in order to monitor the movements of the other movable bodies also increases in the same tendency.

As in the foregoing, in order to achieve the object of the traffic system **1**, the communication device in each movable body that is provided to the vehicle **2** or the like and acquires and collects the movement data is to appropriately collect such a large number of movement data and use the large number of movement data for control of a movement thereof.

The vehicle **2** such as an automobile has no experience of having treated such a large number of data.

However, a vehicle **2** of related art such as an automobile simply has a data processing ability of processing data detected by the host vehicle, and receiving and processing static congestion data into which movements of individual movable bodies are collectively abstracted and partial map data for guiding a path, in an area including the host vehicle position.

In other words, even if a technology enables current vehicles to widely collect information on movable bodies, the current vehicles cannot appropriately acquire widely collected dynamic movement data on a large number of the movable bodies and control the travel and the like of the vehicles based on the acquired dynamic movement data.

Moreover, even if the current vehicle has such a processing ability, there is a possibility that the vehicle cannot move forward at all or that an unnecessarily and excessively reacted movement of the vehicle occurs.

Therefore, it may be contemplated, for instance, that the vehicular communication apparatus delete old movement data to reduce the total amount of movement data that is stored and used therein.

However, when such old movement data is uniformly deleted, there is a possibility that movement data to be deleted may include useful data. Moreover, there is a possibility that unnecessary data may remain in new movement data to be not deleted.

It is desired that the vehicular communication apparatus that is used in the vehicle **2** such as an automobile can excellently acquire movement data on a plurality of movable bodies that is collected in the traffic system **1**, and excellently control the travel and the like of the vehicle **2** based on the acquired movement data.

Hereinafter, measures taken in the present embodiment will be described.

FIG. **4** is an explanatory diagram illustrating an instance of a vehicle control system **10** that is provided with a vehicular communication apparatus according to the embodiment of the disclosure.

The vehicle control system **10** in FIG. **4** is provided to the vehicle **2** as a movable body, and controls the travel and the like of the vehicle **2**.

The vehicle control system **10** in FIG. **4** includes a wireless communicating unit **11**, an image capturing device **12**, a scanning device **13**, a GPS receiver **14**, a travel sensor **15**, an environment sensor **16**, an operation member **17**, the memory **18**, a timer **19**, an electronic control unit (ECU) **20**, and an in-vehicle network **21** that couples these units. A one-chip microcomputer may include the memory **18**, the timer **19**, and the like, in addition to the ECU **20**. This one-chip microcomputer may be coupled to the in-vehicle network **21**.

In FIG. **4**, a vehicular communication apparatus **22** may be configured with, for instance, the wireless communicating unit **11**, the memory **18**, the timer **19**, and the ECU **20**.

The in-vehicle network **21** is a network that couples devices that are provided to the respective units of the vehicle **2**, in the vehicle **2** such as an automobile. The in-vehicle network **21** may be a controller area network (CAN), a local interconnect network (LIN), or Ethernet, for instance. Moreover, the in-vehicle network **21** may include a relay device, and a plurality of communication cables that are coupled to the relay device. In this case, the devices that are provided to the respective units of the vehicle **2** may be distributed and coupled to the plurality of communication cables. The devices that are provided to the respective units of the vehicle **2** transmit and receive data to and from other devices via the in-vehicle network **21**.

The image capturing device **12** captures an image of an inside or a surrounding of the vehicle **2**. The vehicle **2** compatible with the traffic system **1** may be provided with the image capturing device **12** that captures at least an image ahead of the vehicle **2**. In this case, the vehicle **2** acquires a captured image of another vehicle or the like that is travelling ahead of the vehicle **2**.

The scanning device **13** scans another movable body and a fixed installed object that are present in the surrounding of the vehicle **2**, by a radar or the like. This enables the vehicle **2** to detect distances or the like to the other movable body and the fixed installed object that are present in the surrounding of the vehicle **2**.

The GPS receiver **14** receives radio waves from a GPS satellite, and generates current position information on the vehicle **2**. The GPS receiver **14** may receive radio waves from the base station **4** and a radio tower that are fixedly disposed on the ground, and generate or correct the current position information on the vehicle **2**. The vehicle **2** may generate the current position information on the vehicle **2** based on radio waves from the base station **4** that are received by the wireless communicating unit **11**, for instance, different from the GPS receiver **14**, or based on detection about the travel of the vehicle **2**.

The travel sensor **15** detects information related to actual travel of the vehicle **2**. The information related to the actual travel of the vehicle **2** includes, for instance, a speed and a movement direction of the vehicle **2**. The information related to the actual travel of the vehicle **2** may further include, for instance, an operating state of a drive source, an operating state of a transmission, an operating state of a braking device, and a steering state of the vehicle **2**.

The environment sensor **16** detects an actual environment at a position where the vehicle **2** is present. Information on the actual environment includes, for instance, a state of sunshine, a state of rain, a type of road surface, the temperature, and the humidity.

The operation member **17** is a member with which an occupant riding on the vehicle **2** operates the travel and the like of the vehicle **2**. The operation member **17** includes, for instance, a steering wheel, an accelerator pedal, a brake pedal, a shift lever, a wiper switch, a turn signal lever, a start button, and an operation mode switching button. When the occupant operates the operation member **17**, the operation member **17** generates information on the operation, and outputs the information.

The timer **19** measures a time duration or a time, and outputs the time duration or the time.

The wireless communicating unit **11** may simply transmit and receive communication data of the traffic system **1**. The wireless communicating unit **11** performs communication with the base station **4** and the beacon apparatus **5**, for instance, which are used in the traffic system **1**, and performs vehicle-to-vehicle (V2V) communication or V2X communication with the communication devices, which are used in the other movable bodies. The wireless communicating unit **11** may perform communication with one base station **4** or one beacon apparatus **5** that performs communication in a zone designated by the traffic system **1**. In this case, when the vehicle **2** moves over the zone, the traffic system **1** designates one base station **4** or one beacon apparatus **5** that corresponds to a new zone as a destination of a wireless data communication. This enables the wireless communicating unit **11** to transmit and receive the movement data or the like to and from the server apparatus **6** of the traffic system **1** even when the movable body is moving.

Herein, the movement data includes, for instance, identification information, attribute information, position information, position detection time information, speed information, and travel direction information on a movable body. The movement data may include, in addition to these, for instance, time information corresponding to a generation timing of the movement data, and the like.

The identification information on a movable body may be information for identifying the movable body from other different movable bodies. The identification information on a movable body may be an identification number unique to the movable body, for instance. As for the identification number on a movable body, for instance, a vehicle body number and a serial number that are assigned to the vehicle **2**, a MAC address and an IP address that are assigned to the wireless communicating unit **11**, and the like may be used.

The attribute information on a movable body is information indicating the type of the movable body. The types of the movable body include, for instance, the vehicle **2**, the pedestrian **3**, a bicycle, a dog, a child, and an elderly person. When the movable body is the vehicle **2**, the attribute information may include, for instance, information on a manufacturer of the vehicle body, a vehicle type, a model number, a color number, an image of appearance, an exterior option to be made, the type of tires, the type of wheels, a vehicle body number, and the like.

The position information on a movable body may be position information generated by the GPS receiver **14**, for instance.

The position detection time information on a movable body may be a measurement time by the timer **19** at timing when the GPS receiver **14** receives GPS radio waves, and a measurement time by the timer **19** at timing when the GPS receiver **14** generates position information, for instance.

The speed information on a movable body may be an actual speed of the movable body detected by the travel sensor **15**, for instance.

The travel direction information on a movable body may be an actual movement direction of the movable body detected by the travel sensor **15**, for instance.

The movement data may include a part of these information. The plurality of movable bodies in the traffic system **1** may transmit and receive movement data including different information.

The memory **18** records therein (i) various types of programs that are used in the vehicle **2** and (ii) various data that is used during the execution of the programs. The data to be recorded in the memory **18** includes data acquired in the above-mentioned respective units of the vehicle **2**. The movement data received by the wireless communicating unit **11** is stored and recorded in the memory **18**, for instance.

The ECU **20** reads and executes the program recorded in the memory **18**. This implements a controller of the vehicle **2**. The controller of the vehicle **2** controls the above-mentioned respective units of the vehicle **2**.

FIG. **4** illustrates, as functions of the controller of the vehicle **2** that are implemented by the ECU **20**, a memory managing unit **31**, a receiving controller **32**, a movable body monitoring unit **34**, a transmitting controller **35**, a travel controller **36**, and a path generator **37**.

The memory managing unit **31** manages data to be recorded in the memory **18**, and executes recording, updating, and deleting of data to the memory **18**. The memory managing unit **31** manages the recording of movement data in the memory **18**, for instance.

The receiving controller **32** acquires reception data on another movable body from the wireless communicating unit **11** and processes the reception data on the other movable body. When the reception data is movement data on another movable body, for instance, the receiving controller **32** outputs the acquired movement data on the other movable body to the memory managing unit **31** for recording it in the memory **18**. This stores and records plural pieces of the acquired movement data in the memory **18**.

The movable body monitoring unit **34** monitors movements of a plurality of other movable bodies, based on the information on the plurality of other movable bodies stored and recorded in the memory **18**. The movable body monitoring unit **34** monitors an influence on the course (travel) of the host vehicle, caused by the movement of another movable body, for instance.

The movable body monitoring unit **34** predicts courses of the other movable bodies that are present within a monitoring area including the host vehicle and the course, for instance, and sets a monitoring level for each of the other movable bodies based on a determination as to an intersection with the course of the host vehicle.

The monitoring level for each of the other movable bodies may be classified into, for instance, a high level when the course of another movable body intersects with the course of the host vehicle, a middle level when the course of another movable body approaches the course of the host vehicle, and a low level when the course of another movable body is distant from the course of the host vehicle.

The transmitting controller **35** causes the wireless communicating unit **11** to transmit part or all of the movement data on the plurality of other movable bodies that are stored and recorded in the memory **18**.

The path generator **37** generates a movement path along which a movable body moves to a destination, and outputs information on the generated movement path to the memory managing unit **31** for recording the generated movement path in the memory **18**.

The travel controller **36** controls the travel of the vehicle **2** by self-driving or driving assist. The travel controller **36** adjusts the course of the vehicle **2** in accordance with the operation of the operation member **17** by the occupant, the movement path recorded in the memory **18**, the movement data on the plurality of other movable bodies recorded in the memory **18**, the monitoring result by the movable body monitoring unit **34**, and the like, and controls the travel of the vehicle **2**, for instance.

For instance, the travel controller **36** determines a short-term course based on the amount of operation of the operation member **17** and the movement path, and adjusts the course of the vehicle **2** so as to prevent the short-term course from intersecting with or approaching a course of another movable body. Moreover, the travel controller **36** controls the travel of the vehicle **2** so as to cause the vehicle **2** to move along the generated course.

FIG. **5** is an explanatory diagram illustrating an instance of processing of the receiving controller **32** in FIG. **4**.

For instance, when the wireless communicating unit **11** receives new movement data, the receiving controller **32** may conduct reception processing in FIG. **5** repeatedly or at periodic timing.

At a step ST**1** in the reception processing in FIG. **5**, the receiving controller **32** determines whether the wireless communicating unit **11** has received movement data.

The receiving controller **32** may determine not only whether the wireless communicating unit **11** receives movement data on individual movable bodies but also whether the wireless communicating unit **11** receives movement data on a group of a plurality of movable bodies. Moreover, the receiving controller **32** may simply receive movement data on a group corresponding to a plurality of movable bodies, but may not receive movement data on individual movable bodies, and may make a determination, in some cases.

If the wireless communicating unit **11** has not received movement data, the receiving controller **32** ends the reception processing in FIG. **5**.

If the wireless communicating unit **11** has received movement data, the receiving controller **32** acquires the movement data, and outputs the movement data to the memory managing unit **31**, at a step ST**2**. The memory managing unit **31** stores the newly acquired movement data in the memory **18**. Thereafter, the receiving controller **32** ends the reception processing in FIG. **5**.

The processing in the foregoing is repeated to store plural pieces of movement data on the respective other movable bodies at different times acquired by the receiving controller **32**, in the memory **18**.

FIG. **6** is an explanatory diagram of an instance of processing of the transmitting controller **35** in FIG. **4**.

For instance, when new movement data on the host vehicle is recorded in the memory **18**, the transmitting controller **35** may repeatedly conduct transmission processing in FIG. **6**. Alternatively, at a periodic timing, the transmitting controller **35** may repeatedly conduct the transmission processing in FIG. **6**.

At a step ST**11** in the transmission processing in FIG. **6**, the transmitting controller **35** determines whether the movement data stored in the memory **18** includes data to be transmitted.

If the movement data stored in the memory **18** does not include data to be transmitted, the transmitting controller **35** ends the transmission processing in FIG. **6**.

If the movement data stored in the memory **18** includes data to be transmitted, at a step ST**12**, the transmitting controller **35** acquires the data to be transmitted from the memory **18**, and outputs and transmits the data to be transmitted to the wireless communicating unit **11**. Thereafter, the transmitting controller **35** ends the transmission processing in FIG. **6**.

With the processing in the foregoing, the movement data that is stored in the memory **18** is transmitted to the communication devices of the other movable bodies or the vehicle control system **10**, as appropriate. Each of the communication devices of the other movable bodies or the vehicle control system **10** stores the movement data transmitted from the host vehicle in the memory **18** thereof, and uses the movement data for control of the movement thereof. When movement data on the host vehicle has been recorded in the memory **18**, the transmitting controller **35** may transmit the movement data on the host vehicle with movement data on the other movable bodies, to the communication devices of the other movable bodies or the vehicle control system **10**.

FIG. **7** is an explanatory diagram illustrating an instance of processing of the movable body monitoring unit **34** in FIG. **4**.

The movable body monitoring unit **34** may repeatedly conduct monitoring processing in FIG. **7**, for instance, (i) when a series of movement control by the travel controller **36** has been completed one time, (ii) when new movement data on the host vehicle has been recorded in the memory **18**, or (iii) at periodic timing.

At a step ST**21** of the monitoring processing in FIG. **7**, as for plural pieces of movement data recorded in the memory **18**, the movable body monitoring unit **34** acquires the movement data on a movable-body by movable-body basis or the movement data on a group by group basis. When plural pieces of movement data on each movable body or each group at different times have been stored in the memory **18**, the movable body monitoring unit **34** acquires the plural pieces of movement data.

At a step ST**22**, the movable body monitoring unit **34** predicts and determines, using the acquired movement data, (i) whether the movement of another movable body corresponding to the movement data influences the movement of the host vehicle and (ii) a degree of influence, and determines the monitoring level in accordance with the result of the prediction determination. The movable body monitoring unit **34** predicts courses of the other movable bodies, for instance, from the movement data, and determines whether there is a possibility that the other movable body intersects with or approaches the course of the host vehicle. Moreover, the movable body monitoring unit **34** may calculate an arrival time of the other movable body to the intersecting position or the approaching position and an arrival time of the host vehicle to the intersecting position or the approaching position, and may determine whether there is a possibility that the other movable body intersects with or approaches the course of the host vehicle by considering a time difference therebetween. The movable body monitoring unit **34** uses all the movement data stored in the memory **18** to determine the movement of the other movable bodies with high accuracy.

At a step ST**23**, the movable body monitoring unit **34** assigns a monitoring level to the other movable body based on (i) whether the movement of the other movable body influences the movement of the host vehicle and (ii) the degree of influence.

The monitoring level to be assigned to the other movable body may be, for instance, a high level when the course of the other movable body intersects with the course of the host vehicle, a middle level when the course of the other movable body approaches the course of the host vehicle, and a low level when the course of the other movable body neither intersects with nor approaches the course of the host vehicle.

Repeating the processing in the foregoing enables the movable body monitoring unit **34** to continuously monitor another movable body in accordance with an every-changing movement situation of the other movable body. Moreover, the movable body monitoring unit **34** may classify a plurality of other movable bodies according to the monitoring levels.

FIG. **8** is an explanatory diagram illustrating an instance of processing of the travel controller **36** serving as a vehicle control apparatus in FIG. **4**.

The travel controller **36** may repeatedly conduct traveling processing in FIG. **8**, for instance, (i) when a previous-time series of the movement control by the travel controller **36** has completed, (ii) when new movement data on the host vehicle has been recorded in the memory **18** or (iii) at periodic timing.

At a step ST**31** of the travel processing in FIG. **8**, the travel controller **36** acquires detection data and the like of various host vehicle sensors that are provided to the vehicle **2**.

At a step ST**32**, the travel controller **36** determines whether a travel state of the host vehicle is in an urgent state based on the detection data of the host vehicle sensors. For instance, when detecting running out of the pedestrian **3** or another vehicle into a roadway in an image ahead of the vehicle **2** captured by the image capturing device **12**, the travel controller **36** determines that the travel state of the host vehicle is the urgent state.

If the travel state of the host vehicle is the urgent state, the travel controller **36** causes the processing to proceed to a step ST**36**. At the step ST**36**, the travel controller **36** executes travel control of the vehicle **2** to deal with the urgent situation, and occupant protection control. The travel controller **36** executes, for instance, avoid control to instantly brake the vehicle **2** to be stopped suddenly. Moreover, when the travel sensor **15** detects the high acceleration after having started the control of the sudden stop, the travel controller **36** executes the occupant protection control using a seatbelt and an airbag. In the urgent travel control, the travel controller **36** may transmit movement data on the host vehicle indicating the urgency from the wireless communicating unit **11** to other movable bodies. This enables the other movable bodies to start necessary urgent travel control following the urgent travel control of the host vehicle. The travel controller **36** of the host vehicle may also determine whether the wireless communicating unit **11** has received movement data indicating the urgency from another movable body at the step ST**32**. If the wireless communicating unit **11** has received such movement data, the travel controller **36** may cause the processing to proceed to the step ST**36**.

Thereafter, the travel controller **36** proceeds the processing to a step ST**37**.

If the travel state of the host vehicle is not the urgent state, the travel controller **36** causes the processing to proceed to a step ST**33**. At the step ST**33**, the travel controller **36** acquires the monitoring result by the movable body monitoring unit **34**.

At a step ST**34**, the travel controller **36** generates or adjusts a course of the vehicle **2** in accordance with the monitoring results about the movements of the plurality of movable bodies by the movable body monitoring unit **34**, and updates the course.

The travel controller **36** generates a course during a movement control period this time of the vehicle **2**, for instance, based on the movement path generated by the path generator **37**. For instance, the travel controller **36** generates a course in which the vehicle travels on a present lane without any change when the vehicle travels straight. The travel controller **36** generates a course in which the vehicle changes the lane for right or left turning and travels when the vehicles turns right or left.

Moreover, the travel controller **36** determines, based on the monitoring result, whether there is another movable body having a possibility of intersecting or approaching the course that is used for the movement control this time of the vehicle **2** during the movement control period this time of the vehicle **2**. The travel controller **36** predicts a moving speed and a moving direction of a movable body having a high-level or middle-level monitoring result during the movement control period this time of the vehicle **2**, and determines whether the movable body intersects with or approaches the course of the host vehicle.

When there is no movable body that intersects with or approaches the course of the host vehicle during the movement control period this time of the vehicle **2**, the travel controller **36** adopts the course generated based on the movement path as a course to be used for the control this time and updates the course.

When there is another movable body that intersects with or approaches the course of the host vehicle during the movement control period this time of the vehicle **2**, the travel controller **36** updates the course so as to cause the course generated based on the movement path to be apart from the course of the other movable body. Alternatively, the travel controller **36** updates speed information on the course generated based on the movement path so as to allow the vehicle to stop before the intersecting position or the approaching position.

At a step ST**35**, the travel controller **36** controls the travel of the host vehicle, in accordance with the updated new course, by the control within a range in which the vehicle **2** travels in safety. When the occupant operates the operation member **17** during the control, the travel controller **36** may adjust the course by increasing or decreasing an amount of control relative to an amount of the operation to be close to the updated new course.

At the step ST**37**, the travel controller **36** generates movement data on the host vehicle including new position information on the host vehicle and new time information after the control, and outputs the generated movement data to the memory managing unit **31** to store the movement data in the memory **18**.

Repeating the processing in the foregoing enables the travel controller **36** to continuously control the movement of the host vehicle in accordance with an every-changing movement situation of another movable body.

FIG. **9** is an explanatory diagram of an instance of processing of the memory managing unit **31** in FIG. **4** according to the first embodiment of the disclosure.

At a step ST**41** in data management processing for the memory **18** in FIG. **9**, the memory managing unit **31** determines whether it is timing when movement data on other movable bodies is periodically received from the server apparatus **6**, for instance. In addition to this, for instance, the memory managing unit **31** may determine whether it is periodic timing, such as 10 milliseconds, or may determine whether it is timing that the receiving controller **32** has received new movement data on another movable body. The memory managing unit **31** repeatedly executes the data management processing for the memory **18** in FIG. **9**.

If it is not the timing when movement data or the like is periodically received, the memory managing unit **31** ends the data management processing in FIG. **9**.

If it is the timing when movement data or the like is periodically received, the memory managing unit **31** actually starts the data management processing in FIG. **9**.

At a step ST**42**, the memory managing unit **31** firstly deletes movement data whose disposal cycle has expired, among the movement data on the plurality of movable bodies stored in the memory **18**.

At a step ST**43**, the memory managing unit **31** acquires movement data from the memory **18** on a movable-body by movable-body basis after the delete processing.

At a step ST**44**, the memory managing unit **31** acquires, based on the acquired movement data, an actual speed that is an actual movement speed of another movable body that is obtained from the movement data recorded in the memory **18**. For instance, when the latest movement data includes speed information, the memory managing unit **31** may use the speed information as an actual speed. Moreover, when the movement data include no speed information, the memory managing unit **31** calculates an actual speed from position information and time information in two pieces of the latest movement data.

At a step ST**45**, the memory managing unit **31** calculates a speed change (acceleration) based on the acquired actual speed of the other movable body. For instance, when the movement data includes speed information, the memory managing unit **31** calculates a difference between an actual speed of the latest movement data and an actual speed of the previous movement data, and acquires a speed change.

At a step ST**46**, the memory managing unit **31** determines whether the acquired speed change exceeds a normal range of a speed change that can be assumed in accordance with the type of the other movable body. For instance, when the other movable body is the pedestrian **3**, the normal range of the speed change may be a range of a speed change at which people can generally walk. For instance, when the other movable body is the vehicle **2**, the normal range of the speed change may be a range of a speed change at which the vehicle **2** can generally travel.

If the acquired speed change does not exceed the normal range of the speed change, the memory managing unit **31** causes the processing to proceed to a step ST**48**. At the step ST**48**, the memory managing unit **31** sets a cycle in which the movement data on the other movable body being processed is disposed of to a normal disposal cycle. The normal disposal cycle may be a time twice or three times a cycle in which movement data is generated in each movable body, for instance. Accordingly, even when the movement data includes no speed information, the memory managing unit **31** can conduct arithmetic processing to obtain a speed or a speed change for selecting a disposal cycle, based on the requisite minimum pieces of movement data. It should be noted that the disposal cycle may be changed in accordance with the travel environment and the like.

If the acquired speed change exceeds the normal range of the speed change, the memory managing unit **31** causes the processing to proceed to a step ST**47**. At the step ST**47**, the memory managing unit **31** sets a cycle in which the movement data on the other movable body being processed is disposed of to a cycle that is longer than the normal disposal cycle. This long-term disposal cycle is simply longer than a normal disposal cycle and may be twice to three times the normal disposal cycle. This enables movement data on another movable body the speed change of which is not normal and to which an attention is necessary to be paid, to be stored in the memory **18**. The movement data that is larger than normal one and is stored in the memory **18** enables the movable body monitoring unit **34** to well-monitor the movement of the other movable body, and to excellently determine (i) whether the movement of the other movable body influences the movement of the host vehicle and (ii) the degree of influence on the movement of the host vehicle.

At a step ST**49**, the memory managing unit **31** determines whether the scanning processing has been completed for all the other movable bodies stored in the memory **18**.

If the scanning processing has been not completed for all the other movable bodies, the memory managing unit **31** returns the processing to the step ST**43**, and repeats the processing for next another movable body. Accordingly, the scanning processing is performed for all the other movable bodies the movement data of which is stored in the memory **18**, and a disposal cycle is set in accordance with each speed change. At the processing at the step ST**42** next time, the memory managing unit **31** can delete movement data whose disposal cycle has expired from the memory **18**, as for the other movable bodies.

Thereafter, the memory managing unit **31** ends the data management processing in FIG. **9**.

By repeating the data management processing in the foregoing, the memory managing unit **31** can periodically delete the movement data that has become old from the memory **18** on a movable-body by movable-body basis in accordance with the actual speeds of the other movable bodies. This prevents the amount of data stored in the memory **18** from continuously increasing with time. It is possible to appropriately store the movement data on a plurality of other movable bodies using the memory **18** having a limited storage capacity.

It should be noted that the memory managing unit **31** may not instantaneously delete movement data whose disposal cycle has expired at the determination timing, but may invalidate the movement data and then overwrite the movement data at timing when the storage capacity of the memory **18** becomes insufficient, thereby deleting the movement data from the memory **18**. In this case, the movable body monitoring unit **34** may monitor a movement on each of the other movable bodies only based on the valid movement data that has not been invalidated.

Moreover, in the processing in FIG. **9**, the memory managing unit **31** adjusts the disposal timing of the movement data based on the disposal cycle. In addition to this, the memory managing unit **31** may adjust the disposal timing of the movement data based on the disposal frequency.

As in the foregoing, in the present embodiment, movement data acquired in order to be used in the control of the traveling of the vehicle **2** is stored and recorded in the memory **18**, and the memory managing unit **31** manages the recording of the movement data in the memory **18**. Moreover, the memory managing unit **31** acquires an actual speed of each movable body that is obtained from the recorded movement data recorded in the memory **18**, and periodically deletes or invalidates the movement data from the memory **18** on the movable-body by movable-body basis in accordance with the actual speed of each movable body acquired from the movement data stored in the memory **18**.

For instance, the memory managing unit **31** deletes or invalidates the past movement data from the memory **18** on the movable-body by movable-body basis at the disposal cycle which is acquired from the normal disposal cycle and the long-term disposal cycle in accordance with the degree of the change (acceleration) in actual speed of each of the other movable bodies. Specifically, for instance, when the change in the actual speed of the movable body is within the predetermined normal range of the speed change, the memory managing unit **31** deletes or invalidates the past movement data from the memory **18** on the movable-body by movable-body basis in the normal disposal cycle. When the change in the actual speed of the movable body is not within the predetermined normal range of the speed change, the memory managing unit **31** deletes or invalidates the past movement data from the memory **18** on the movable-body by movable-body basis in the long-term disposal cycle.

Therefore, for instance, when the change in the actual speed of a movable body exceeds the predetermined normal range of the speed change, movement data on the movable body is stored and recorded in the memory **18** during a long period. Movement data having a possibility that the movement data is useful in control of the travelling and the like of the vehicle **2** can be stored and recorded in the memory **18** during the long period. Moreover, when the change in the actual speed of the movable body falls within the predetermined normal range of the speed change, movement data on the movable body is deleted from the memory **18** in the normal period. Movement data having a possibility that the movement data is unnecessary in control of the travelling and the like of the vehicle **2** can be deleted from the memory **18** early. The movable body monitoring unit **34** can more surely predict individual movement statuses of the other movable bodies, using the movement data that has been appropriately stored in the memory **18**. Moreover, compared with a case where the movement data in the memory **18** is uniformly kept in the long-term disposal cycle, and thereafter, is deleted, it is possible to reduce the storage capacity necessary for the memory **18**.

As a result, in the present embodiment, it is possible to excellently acquire and store movement data of a plurality of other movable bodies that can be collected in the traffic system **1**, in the vehicle **2**, such as an automobile. Moreover, in the present embodiment, based on the movement data that has been suitably acquired and stored, it is possible to excellently control the travelling and the like of the vehicle **2**.

Moreover, in the present embodiment, the movement data stored in the memory **18** is appropriately deleted, so that it is possible to reduce the storage capacity of the memory **18** and the processing load of the ECU that processes the movement data. For instance, in the present embodiment, it is possible to prevent the control of the vehicle **2** from becoming impossible, prevent a situation where the vehicle **2** does not travel forward, and prevent the vehicle **2** from excessively reacting, due to the overflow of the movement data to be stored in the memory **18**.

In the present embodiment, the memory managing unit **31** deletes or invalidates the past movement data from the memory **18** on the movable-body by movable-body basis at the timing when the movement data is received and collected in accordance with a cycle in which movement data on the other movable bodies is periodically received from the server apparatus **6** or the like. Therefore, it is possible to delete unnecessary movement data in accordance with the cycle in which movement data on the other movable bodies is received. The data amount of movement data that is stored in the memory **18** can be reduced to an amount corresponding to the timing when movement data is periodically received.

Second Embodiment

Next, the traffic system **1** according to a second embodiment of the disclosure will be described. In the present embodiment, the same reference signs are used for configurations similar to those in the above-described embodiment, and illustration and explanations thereof will be omitted. In the following explanation, differences from the above-described embodiment will be mainly described.

FIG. **10** is an explanatory diagram of an instance of processing of the memory managing unit **31** in FIG. **4** according to the second embodiment of the disclosure.

The processing from the steps ST**41** to ST**49** in FIG. **10** is similar to that at the steps in FIG. **9** in the above-described embodiment.

After having acquired movement data on each of other movable bodies from the memory **18** after the delete processing at the step ST**43**, the memory managing unit **31** determines, using position information on the other movable body, whether the other movable body is present in a distant place far in distance from the host vehicle at a step ST**51**. If the other movable body is present in a distant place where the other movable body does not influence on the travelling of the host vehicle, the memory managing unit **31** causes the processing to proceed to the step ST**48**, and sets the normal disposal cycle for the other movable body. A determination distance for a distant place may be several tens to several hundreds meters, when the other movable body is the vehicle **2**, for instance. When the other movable body is the pedestrian **3**, the determination distance may be a movement distance in a control cycle based on the movement speed of the host vehicle.

If the other movable body is not present in a distant place from the host vehicle, the memory managing unit **31** causes the processing to proceed to a step ST**52**. At the step ST**52**, the memory managing unit **31** determines a possibility that the other movable body does not come into contact with the host vehicle. When it is considered that the other movable body travels on a road of a different category, the memory managing unit **31** determines that there is no contact possibility between the other movable body and the host vehicle. For instance, a highway is different in category from an ordinary road. Moreover, the memory managing unit **31** may determine that there is no contact possibility, with respect to another movable body that is apart by several hundreds or more meters from the host vehicle. If there is no contact possibility between the other movable body and the host vehicle, the memory managing unit **31** causes the processing to proceed to the step ST**48**, and sets the normal disposal cycle for the other movable body.

If the memory managing unit **31** cannot determine that there is no contact possibility between the other movable body and the host vehicle, the memory managing unit **31** causes the processing to proceed to the step ST**44**, and sets a disposal cycle in accordance with the degree of change in the actual speed at the steps ST**44** to ST**48**.

In this case, the memory managing unit **31** calculates a long-term disposal cycle for another movable body, at the step ST**53**.

For instance, the memory managing unit **31** calculates (i) a time when another movable body a course of which is expected to intersect with the host vehicle arrives at an intersecting position, and (ii) a time when the host vehicle arrives at the intersecting position, based on the respective movement data. Then, the memory managing unit **31** sets the shorter time among those arrival times as a long-term disposal cycle of another movable body. When the arrival time of another movable body is shorter than that of the host vehicle, there is a high possibility that another movable body passes through the intersecting position before the host vehicle arrives at. Therefore, the memory managing unit **31** sets the arrival time of another movable body as a long-term disposal cycle. When the arrival time of another movable body is longer than that of the host vehicle, there is a high possibility that another movable body arrives at the intersecting position after the host vehicle has passed. Therefore, the memory managing unit **31** sets the arrival time of the host vehicle as a long-term disposal cycle. When a difference between the arrival time of the host vehicle and the arrival time of another movable body is small, and when there is a high possibility that the host vehicle is influenced, the memory managing unit **31** sets a time obtained by adding a control time to the arrival time, as a long-term disposal cycle. Accordingly, when the host vehicle and another movable body arrive at the intersecting position at the approximately same time, the travel controller **36** can conduct effective prevention control by utilizing movement data on the other movable body. For instance, the travel controller **36** can decelerate the vehicle **2** short of the intersecting position, and wait until another movable body has passed.

Thereafter, at the step ST**49**, the memory managing unit **31** determines whether the scanning processing has been completed for all the other movable bodies stored in the memory **18**. The subsequent processing by the memory managing unit **31** is similar to that described in the embodiment described above.

As described in the foregoing, in the present embodiment, the memory managing unit **31** deletes or invalidates, among the movement data recorded in the memory **18**, movement data on other movable bodies that are determined to be unlikely to come into contact with the host vehicle and movement data on other movable bodies that are far in distance from the host vehicle, from the memory **18** on the movable-body by movable-body basis. Therefore, movement data having a high possibility of becoming unnecessary on other movable bodies which are unlikely to come into contact with the host vehicle and other movable bodies that are far in distance are appropriately deleted in the normal disposal cycle independent of the change in speed of the movable bodies, without setting the long-term disposal cycle based on the actual speed and the speed change.

In the present embodiment, as for another movable body a course of which is expected to intersect with a course of the host vehicle, the memory managing unit **31** uses, as a disposal cycle longer than the normal disposal cycle, a disposal cycle or a disposal frequency of the other movable body that has been changed using a time shorter between a time when the other movable body arrives at an intersecting position and a time when the host vehicle arrives at the intersecting position as a reference. Therefore, until the time when the host vehicle or another movable body arrives at the intersecting position, it is possible to store the movement data on the other movable body in the memory **18**. It is possible to appropriately store and keep movement data having a high possibility of becoming necessary, in the memory **18**, in a period having a high possibility that the movement data becomes necessary.

The embodiments in the foregoing are preferred examples of the disclosure. However, the disclosure is not limited to these embodiments. Many modifications and changes may be made to the embodiments without departing from the sprit and scope of the disclosure.

For instance, in the above embodiments, when the change in the actual speed of another movable body deviates from the normal change range, the memory managing unit **31** starts or restarts storing movement data on another movable body in the memory **18**.

In addition to this, when the actual speed of another movable body deviates from the normal speed range, the memory managing unit **31** may start or restart storing movement data on the other movable body in the memory **18**.

Moreover, when at least one of the actual speed or the change in the actual speed deviates from each normal range, the memory managing unit **31** may start or restart storing movement data on another movable body in the memory **18**.

In the above embodiments, the vehicle control system **10** and the communication device which are provided to the movable body use the movable body monitoring unit **34** and the travel controller **36** in order to control the movement of the vehicle **2** based on the movement data stored in the memory **18**.

Alternatively, for instance, the vehicle control system **10** and the communication device that are provided to the movable body may conduct processing similar to that of the movable body monitoring unit **34** in the processing of the travel controller **36**, and simply use the travel controller **36**. In this case, the travel controller **36** may conduct processing similar to that of the movable body monitoring unit **34** at the step ST**43** in FIG. **9**, for instance. Moreover, when the movable body monitoring unit **34** is integrated with the travel controller **36**, the travel controller **36** may update, without assigning a monitoring level, the course so as to adjust the course, using the monitoring determination result as it is.

In the above embodiments, the vehicle control system **10** and the communication device that are provided to the movable body includes the receiving controller **32** and the memory managing unit **31**.

Alternatively, for instance, the vehicle control system **10** and the communication device that are provided to the movable body may integrate the memory managing unit **31** with the receiving controller **32**, and cause the receiving controller **32** to conduct the delete processing of the movement data from the memory **18**. In this case, the receiving controller **32** sets a disposal cycle for each of the movable bodies when receiving movement data, for instance, and may delete the movement data whose disposal cycle has expired, from the memory **18** on the movable-body by movable-body basis.

In the above embodiment, the vehicle control system **10** and the communication device that are provided to the movable body includes the travel controller **36** and the transmitting controller **35**.

Alternatively, for instance, the vehicle control system **10** and the communication device that are provided to the movable body may integrate the transmitting controller **35** with the travel controller **36**, and cause the travel controller **36** to conduct the transmission processing of the movement data. In this case, the travel controller **36** may transmit the stored movement data on the host vehicle by the wireless communicating unit **11**, after the processing at the step ST**47** in FIG. **9**, for instance.

In the above embodiment, the vehicle control system **10** provided to the vehicle **2** is provided with the respect units illustrated in FIG. **4**. Alternatively, for instance, the vehicle control system **10** may be provided with a part of the functions in FIG. **4**. Moreover, the vehicle control system **10** may be provided with all of the functions in FIG. **4** by the remaining functions in FIG. **4** being provided by a mobile terminal, for instance, with respect to the part of the functions in FIG. **4**, which are uniquely provided.

Moreover, the vehicle control system **10** may be provided a part of the functions in FIG. **4**, and may conduct the above-mentioned various processing in that state. The vehicular communication apparatus **22** may be provided with a part of the functions in FIG. **4**, as the host vehicle sensor to be mounted on the vehicle **2**, for instance. Specifically, when conducting the control other than the travel in the vehicle **2**, the vehicle control system **10** does not need to be provided with all the host vehicle sensors in FIG. **4**, the operation member **17**, and the path generator **37** of the ECU **20**. Even in this case, the vehicular communication apparatus **22** that is provided to the vehicle control system **10** configures the traffic system **1** that transmits and receives movement data and the like to and from the server apparatus **6**.

In the above embodiment, the vehicular communication apparatus **22** has been described as a part of the vehicle control system **10**. A control system for a low-speed movable body such as the pedestrian **3** and a bicycle may be also provided with functions similar to those of the above-mentioned the vehicular communication apparatus **22**. Moreover, the above-mentioned vehicle control system **10** and the vehicular communication apparatus **22** may be also applied to the vehicle **2** of a different type, such as an electric train, other than the vehicle **2**.

The invention claimed is:

1. A vehicular communication apparatus configured to receive movement data related to a movement of other movable bodies, the vehicular communication apparatus comprising:

a controller configured to:
- control acquisition of the movement data on the other movable bodies;
- control a memory to store and record therein the acquired movement data;
- manage the record of the movement data in the memory;
- control acquisition of a speed of each movable body of the other movable bodies from the movement data recorded in the memory;
- control invalidation or deletion of the movement data in the memory, on a movable-body by movable-body basis, in a first disposal cycle or at a first disposal frequency, when a change in the speed of each movable body of the other movable bodies is within a predetermined range of a speed change; and
- control invalidation or deletion of the movement data in the memory, on the movable-body by movable-body basis, in a second disposal cycle longer than the first disposal cycle or at a second disposal frequency less than the first disposal frequency, when the change in the speed of each movable body of the other movable bodies is not within the predetermined range of the speed change.

2. The vehicular communication apparatus according to claim **1**, wherein the second disposal cycle or the second disposal frequency is acquired from a plurality of disposal cycles or a plurality of disposal frequencies in accordance with a degree of the change in the speed of the each movable body.

3. The vehicular communication apparatus according to claim **1**, wherein the controller is configured to control invalidation or deletion of the movement data in the memory on the movable-body by movable-body basis in accordance with a cycle in which the movement data on the other movable bodies is acquired.

4. The vehicular communication apparatus according to claim **2**, wherein the controller is configured to control invalidation or deletion of the movement data in the memory on the movable-body by movable-body basis in accordance with a cycle in which the movement data on the other movable bodies is acquired.

5. The vehicular communication apparatus according to claim **1**, wherein the controller is configured to control, among the movement data recorded in the memory, invalidation or deletion of the movement data on a first set of movable bodies of the other movable bodies that are determined not to come into contact with a host vehicle and the movement data on a second set of movable bodies of the other movable bodies that are at a position farther than a specific distance from the host vehicle, on the movable-body by movable-body basis.

6. The vehicular communication apparatus according to claim **2**, wherein the controller is configured to control, among the movement data recorded in the memory, invalidation or deletion of the movement data on a first set of movable bodies of the other movable bodies that are determined not to come into contact with a host vehicle and the movement data on a second set of movable bodies of the other movable bodies that are at a position farther than a specific distance from the host vehicle, on the movable-body by movable-body basis.

7. The vehicular communication apparatus according to claim **1**, wherein

the controller is configured to control invalidation or deletion of the movement data, on the other movable bodies courses of which are expected to intersect with that of a host vehicle, on the movable-body by movable-body basis in a disposal cycle of each of the other movable bodies or at a disposal frequency of each of the other movable bodies, and

the disposal cycle of each of the other movable bodies or the disposal frequency of each of the other movable bodies being changed using a shorter time among (i) a time when the each movable body arrives at an intersecting position and (ii) a time when the host vehicle arrives at the intersecting position as a reference.

8. The vehicular communication apparatus according to claim **2**, wherein

the controller is configured to control invalidation or deletion of the movement data, on the other movable bodies courses of which are expected to intersect with that of a host vehicle, on the movable-body by movable-body basis in a disposal cycle of each of the other movable bodies or at a disposal frequency of each of the other movable bodies, and

the disposal cycle of each of the other movable bodies or the disposal frequency of each of the other movable bodies being changed using a shorter time among (i) a time when the each movable body arrives at an intersecting position and (ii) a time when the host vehicle arrives at the intersecting position as a reference.

9. A vehicle control system comprising:

the vehicular communication apparatus according to claim **1**; and

a vehicle control apparatus that includes circuitry configured to control a vehicle using the movement data recorded in the memory of the vehicular communication apparatus.

10. A vehicle control system comprising:

the vehicular communication apparatus according to claim **2**; and

a vehicle control apparatus that includes circuitry configured to control a vehicle using the movement data recorded in the memory of the vehicular communication apparatus.

11. A traffic system comprising:

the vehicular communication apparatus according to claim **1**; and

a server apparatus configured to transmit and receive the movement data related to the movement of the other movable bodies to and from the vehicular communication apparatus.

12. A traffic system comprising:

the vehicular communication apparatus according to claim **2**; and

a server apparatus configured to transmit and receive the movement data related to the movement of the other movable bodies to and from the vehicular communication apparatus.

13. A vehicular communication apparatus configured to receive movement data related to a movement of other movable bodies, the vehicular communication apparatus comprising circuitry configured to:

acquire the movement data on the other movable bodies;

store and record therein the acquired movement data;

manage the record of the movement data in a memory;

acquire a speed of each movable body of the other movable bodies from the recorded movement data in the memory;

invalidate or delete the movement data in the memory, on a movable-body by movable-body basis, in a first disposal cycle or at a first disposal frequency, when a change in the speed of each movable body of the other movable bodies is within a predetermined range of a speed change; and

invalidate or delete the movement data in the memory, on the movable-body by movable-body basis, in a second disposal cycle longer than the first disposal cycle or at a second disposal frequency less than the first disposal frequency, when the change in the speed of each movable body of the other movable bodies is not within the predetermined range of the speed change.

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